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NATURAL AND ARTIFICIAL INCUBATION OF HENS' EGGS



THE HEN is the best incubator for most farmers, but incubators may be used to advantage on many farms. February, March, and April are the best months for hatching. Early hatching is essential for the best results.

For hatching, select uniformly good-sized eggs from fowls kept on free range or having good yards.

Treat the hen for lice before setting her. Place from 10 to 13 eggs under a hen in cold weather and from 13 to 15 in warm weather.

Sitting hens need careful, regular attention.

All eggs should be tested by the seventh day, which often makes it possible to reset some of the hens. Test the eggs again on the fourteenth day.

A well-ventilated cellar is the best place to operate an incubator. The machine should be operated according to the manufacturer's directions. See that the incubator is running steadily at the desired temperature before filling it with eggs. Do not add eggs to a machine during incubation.

Turn the eggs twice daily after the second and through the eighteenth day. Be sure to turn the eggs before caring for the lamp, so that no kerosene will get on the eggs through handling.

Cool the eggs once daily, according to the weather, from the seventh through the eighteenth day.

Attend to the machine carefully at regular hours. Keep the lamp and wick clean.

Do not open the machine after the eighteenth day until the chickens are hatched.

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NATURAL AND ARTIFICIAL INCUBATION OF HENS' EGGS.

ALFRED R. LEE, *Poultryman, Animal Husbandry Division.*

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STUDY OF AN EGG.

THE PROBLEMS OF INCUBATION will be better understood by a brief study of an egg and the reasons for some of the rules for handling eggs during incubation. The shell of an egg is porous, consisting of an outer and an inner layer, under which are two membranes, separated at the large end of the egg, which form an air cell. This air space, which in a fresh egg is about as large as a 10-cent piece, increases in size directly in proportion to the evaporation of the water in the egg. Under these membranes and surrounding the yolk is the white or albumen. Two coiled membranous layers of dense albumen, called chalazæ, connect the opposite sides of the yolk with each end of the shell and tend to lessen its movement and regulate its position in the egg. The germ spot or blastoderm is a semiopaque spot from one-sixteenth to one-eighth of an inch in diameter, is located on the upper surface of the yolk, and always remains uppermost in the egg.

SELECTION AND CARE OF EGGS FOR HATCHING.

Careful selection and management of the breeding stock and proper care and selection of eggs for hatching are two essential factors in producing good chicks. Fertile eggs with good vitality are the prime essential in good hatches. These are obtained only from stock which is properly housed and which is mated and managed so

that health and vigor are kept at the highest point. Eggs from either immature or overfat breeding stock will not produce a large percentage of strong chicks. Breeding stock should be fed a varied supply of grains, meat, and green feed. The green feed assists in keeping fowls in good breeding condition and is especially essential if the birds are confined in yards. Free range helps materially in the production of hatchable eggs, as it is much easier to keep up the vitality of stock handled in this manner than in birds that are yarded.

Only fresh eggs should be set. Eggs deteriorate after they are five days old, while eggs three weeks or more old usually will not hatch. One of the quickest ways to bring about uniformity in the offspring and to increase the size of the eggs is to select for hatching uniformly good-sized eggs of the same color. Abnormal, small, or poorly shaped eggs should be discarded, as well as eggs which have thin or very porous shells. Dirty eggs should be cleaned by rubbing lightly with a damp cloth, but care should be taken not to rub off any more of the natural bloom of the egg than is absolutely necessary. Duck eggs usually require washing, which does not injure their hatching qualities. In freezing weather eggs for hatching should be collected two or three times a day to prevent chilling.

Eggs in large numbers are generally kept in a cabinet or turning rack, for convenience in handling, and should be kept in a dry, cool place, free from drafts and dust. It is not necessary to turn eggs unless they are held more than five days, after which they should be turned daily. Various commercial turning devices are used for this purpose, or the eggs may be kept in cabinet drawers and shuffled about by hand.

Eggs from different varieties of the same class of poultry may be incubated together, but it is not advisable to mix thin-shelled white eggs from the egg breeds, such as Leghorns, with thick-shelled brown eggs, or eggs from the smaller breeds, with those from the larger breeds, as some may hatch a little earlier than the others.

Neither hens nor incubators will hatch strong chickens from weak germs or from eggs which have not received proper care.

MATING STOCK FOR PRODUCING EGGS FOR HATCHING.

When the birds are yarded, from 8 to 12 females of the American, or general-purpose, class or from 12 to 15 of the Mediterranean class may be mated with one male, depending on his age and vitality. This proportion may be increased if the birds have free range. Hens 1 or 2 years old make the best breeders, but early maturing pullets may also be used to advantage, although it is better not to breed continually from pullets. A good-sized, vigorous, early ma-

turing male should be selected for mating. Do not breed from males which are small, poorly developed, or in poor physical condition. Cockerels should usually be mated with hens that are 1 or 2 years old, while cock birds are mated with either pullets or older hens. Fowls make the best breeders during their first two breeding years and only the very best should be kept longer than this period. Mating should be made at least three weeks before the eggs are to be used for hatching, although fertility sometimes will be satisfactory in seven days. The previous mating sometimes affects the fertility of the eggs for 18 days, but usually this does not last over 10 days.

METHODS OF PACKING HATCHING EGGS.

Eggs for hatching are successfully shipped over long distances on an extensive scale, but rough handling in shipment affects the hatching qualities of the eggs. Setting eggs for shipment are packed in several different ways. One of the best methods is to use a common market basket, well lined with excelsior, in which the eggs are also individually packed in excelsior and the top of the basket is covered with cloth. Eggs are also shipped by packing them in chaff or bran in a stiff pasteboard carton or box which is placed in a larger basket lined with excelsior and covered with cloth. Cartons made to hold from one to several settings are also used for shipping eggs. Some of these cartons or egg boxes are fitted with a handle for carrying, similar to that on a market basket. Bushel baskets are commonly used to ship from 10 to 12 settings of eggs, the manner of packing and covering being the same as mentioned in the first method. It is customary to rest eggs for hatching for about 12 hours after they are received to allow the germ to regain its normal position before the eggs are placed in the incubator.

PERIOD OF INCUBATION.

The period of incubation varies with different species of poultry, as shown in the accompanying table:

Period of incubation.

Kind of poultry.	Days.	Kind of poultry.	Days.
Hen.....	21	Peafowl.....	23
Pheasant.....	23	Guinea.....	26-28
Duck.....	28	Ostrich.....	42
Duck (Muscovy).....	33-35	Goose.....	29-31
Turkey.....	28		

The period of incubation varies somewhat with conditions, so that a hatch may run one or two days over in some cases, as a result of an accident during incubation or of a low temperature throughout that period, while, on the other hand, it may come off earlier. If through any accident the eggs are chilled or overheated, it is advisable to continue the hatch, testing the eggs after a few days to determine the extent of the damage. Chickens have been hatched from eggs left out of the incubator all night, as well as from eggs which have been subjected to a temperature of over 110° F. for a short time. Eggs greatly overheated should be sprinkled liberally with cold water to reduce the heat quickly.

TIME OF THE YEAR TO HATCH CHICKENS.

February, March, and April are usually the best months to hatch chickens, depending materially on the purpose as well as on the climatic conditions. The best time to hatch Leghorns is from March 25 to April 30 and for general-purpose breeds from March 15 to April 15 in the latitude of Washington, D. C. These dates should vary up to 30 days earlier than this in the extreme southern part and to 25 days later in the northern part of the United States. Chickens are hatched commercially in California from September until June, inclusive, with the greatest demand for chicks coming in March and April and in September and October. Many of the commercial egg farms in the northeastern part of the United States hatch a part of their Leghorns in February, and most of the pullets hatched at that time go through a molt in December and January, but produce eggs freely in the fall and also make good breeders the following spring. Chickens are hard to raise in cold, wet, or hot weather, and should not be hatched later than May 15 in the latitude of Washington, D. C., while an earlier date should complete the time of hatching farther south. Early hatched chickens bring the greatest returns, as the pullets make the best fall layers and the broilers are sold at good prices. The smaller breeds can be hatched later than those which are larger and slower to develop, as the former mature about a month earlier.

NATURAL INCUBATION.

Natural incubation is adapted for raising a small number of chickens on general farms and for small suburban flocks. System and care in the management of sitting hens will produce a considerable number of chickens without undue labor. Artificial incubation is advisable in many cases in reproducing stock where poultry is only a side issue on general farms and in small flocks. The incubator can be set at any time, while it is often impossible to

obtain broody hens as early in the season as it is advisable to hatch chickens for the best results. Even with the best of care some hens prove to be fickle mothers and cause trouble and loss in hatching by breaking their eggs, leaving their nests, or trampling on the chickens when first hatched. Most hens of the general-purpose breeds make good mothers. The heavier class, or meat breeds, including the Brahmas and Cochins, make good sitters, but are inclined to be clumsy on the nest.

If only a few hens are set, special quarters are not necessary, but if many are used a separate room should be provided for the sitters.



FIG. 1.—Method of preparing a nest and setting a hen. Note the wire cover which prevents the hen from leaving the nest.

Various styles of nests are used for sitting hens, the one shown in Figure 1 being 18 inches square and 8 inches high. The wire frames which go over the nests (as shown in Fig. 1) prevent the hens from leaving their nests and disturbing one another. The nests may be arranged in tiers 15 inches square and high, with a hinged front which makes a platform for each tier when open. The lower part of the front should be 6 inches high. It is desirable to place 3 or 4 inches of damp earth in the bottom of the nest. Then nesting material is put in, and may consist of hay, chaff, or straw. Pack this material down firmly and shape a circular nest out of it, which should be slightly deeper in the center than at the edges, as a nest so shaped prevents the eggs from rolling out from under the hen and becoming chilled.

HOW TO SET A HEN.

A broody hen makes a clucking noise and ruffles up her feathers when approached. After she has remained on the nest for two or three successive days, remove her carefully at night to a nest containing a few china eggs and which is in a quiet place. Treat her for lice by applying pinches of sodium fluorid on different parts of the body. Be sure that the nest box is free from mites; treat the box if necessary. Keep the hen confined to this nest until the second afternoon, when she should be allowed to come off for feed and water. If she then comes back to her nest, remove the china eggs and put under those to be incubated. If the nests are slightly darkened the hens are less likely to become restless. At hatching time they should be confined and not disturbed until the hatching is completed, unless they



FIG. 2.—Outside nests for setting hens. The hens are fastened to stakes by strings tied around their legs.

become restless, when it may be best to remove the chicks that are hatched first. In cool weather it is best not to put more than 10 eggs under a hen, while later in the spring one may put from 12 to 15, according to the size of the hen.

CARE OF THE SITTING HEN.

Confine the hens to the nests, allowing them to come off only once a day to receive feed and water, the feed to consist of corn or wheat or both. If there are any that do not desire to come off, they should be taken off. Hens usually return to their nests before there is any danger of the eggs chilling; but if they do not go back in half an hour in ordinary weather, they should be put on the nest. Where a large number of sitters are kept in one room it is advisable to let

them off in groups of from four to six at a time. The eggs and nests should be examined and cleaned, removing all broken eggs and washing those that are soiled. In the latter case the soiled nesting material should be removed and clean straw added. Nests containing broken eggs that the hen is allowed to sit on soon become infested with mites and lice, which cause the hens to become uneasy and leave the nest, often resulting in the loss of valuable sittings of eggs.

Many eggs that are laid late in the winter and early in the spring are infertile and should be removed. For that reason it is advisable to set several hens at the same time. After the eggs have been under the hen for seven days they should be tested, the infertile eggs and those with dead germs removed, and the fertile eggs put back under the hen. In that way it is often possible to combine the remaining eggs under fewer hens and reset the other hens.

ARTIFICIAL INCUBATION.

Artificial incubation is used extensively all over the country by all kinds of poultry keepers. It is the only practicable method for use on commercial poultry farms. It also has its place on a general farm and in the suburban poultry flock where poultry is only a side issue. A large number of hatcheries have been developed where the hatching and sale of baby chicks is the sole business and where millions of chicks are hatched each year.

TYPES OF INCUBATORS.

There are on the market a large number of different makes of incubators which are being used successfully in various parts of the United States. These incubators are of two general types, namely, small machines holding from 60 to 400 eggs, usually heated with kerosene lamps, and machines of larger capacity, called mammoth incubators, holding from 2,000 to 10,000 eggs each. The majority of these large machines are heated by coal stoves with hot-water pipes circulating through the incubator, but lamps are also used for some makes. Gas and electricity are used successfully for both small and large incubators. Gas is not generally available in many country sections where incubators are ordinarily operated, but the use of electricity in incubation is increasing, although it is too high priced in most sections to be as economical as coal or oil. Electricity is used more extensively in the extreme western part of the country where electric rates are comparatively low.

The small lamp machines are of two general types, hot air and hot water. Both styles are used successfully in all parts of the country and there does not seem to be much difference in their com-

parative value. The hot-water incubator will hold its heat longer than the hot-air machine in case the lamp should go out, but the possibility of such an accident is too slight to be worth considering when the incubator receives proper attention.

Many styles of incubators have some device for supplying moisture in the machine, such as a sand tray in the bottom or a tray in the upper part. Other machines have no moisture device of this nature. Both styles are used successfully in all parts of the country. The so-called "moisture" machines are especially adapted for a very dry climate or for a dry room or a very dry cellar. These moisture machines are also operated successfully in ordinary cellars and in a humid climate.

The thermostat in the incubator is the device which regulates the heat. It works by the effect of expansion and contraction from heat. Some of these thermostats are bars made of a combination of two metals, while others are known as wafer or disk thermostats and contain a fluid that expands and contracts with changes in temperature. Both styles work successfully, but the bar thermostat usually lasts longer than the wafer regulator. It is important that the thermostat be made of good material, as the failure of this part of the incubator to work properly may ruin the hatch.

There are two styles of incubator thermometers with various modifications. One is placed on the egg tray, while the other is hung over the eggs so that the bulb just clears the top of them. The thermometer should be used according to the manufacturer's rules unless there is a very good reason for making a change. Where the thermometer is placed on the tray or laid on the eggs some operators prefer to have the bulb come in contact with two eggs, so that it may record the temperature of at least one fertile egg.

The position of the thermometer in the egg chamber has a relation to the proper temperature at which to operate the machine, as a difference of an inch in height in some egg chambers will mean at least a degree of difference in temperature. The thermometer is usually placed about 8 inches from the front of the egg tray so that it can be easily read.

It is advisable to test the thermometers once a year with a clinical thermometer, which may be procured from a physician or at a drug store. This can be done by putting both thermometers in warm water, heated at about 103° F., which should be kept stirred, taking care to keep the bulbs near each other and at the same level in the water. If the incubator thermometer is correct it will register the same as the clinical thermometer.

It is important that the lamp be of good size and large enough to hold sufficient oil to burn for 36 hours.

SELECTING AN INCUBATOR.

A large number of reliable makes of incubators are manufactured in this country. The department can not undertake to recommend any particular make. Some machines have become popular in certain sections of the country because they were advertised extensively in those sections rather than on account of special adaptability to the climatic conditions. Cheap machines are less reliable, require more attention, and wear out much more quickly than higher-priced incubators. As the value of the machine is small compared with the value of the eggs used during the normal life of an incubator, it is poor economy to purchase a machine which is not reliable. Whenever possible it is well to select an incubator which is giving satisfaction in your vicinity, so that you may get the benefit of the experience of other operators there.

The best size of incubator to buy depends on circumstances. It takes about as much time to care for a 60-egg machine as for one with a capacity of 360 eggs; it is generally advisable to get one of at least 150-egg capacity, although special conditions may make smaller machines desirable. A small machine is often used in connection with a larger one, all the eggs being placed in the large machine after the first or second test. Incubators of from 300 to 400 egg capacity are generally used on those large farms which use individual lamp incubators, but practically all large poultry farms installing new machines now purchase the large or mammoth incubators. Many poultrymen believe that it pays to have an incubator capacity large enough to hatch the bulk of their stock in two or three hatches, so that much time is saved in looking after the incubators and brooders, while the chickens are more even in size than those that are hatched when the incubating period extends over a longer time. A large number of poultrymen do considerable outside hatching, either selling day-old chicks or doing custom hatching for other persons, so that most poultry farms carry a considerably larger incubator capacity than is required for reproducing their own stock. A fair estimate for a poultry farm is an incubator space of 1-egg capacity per hen, provided that about one-half of the flock is to be renewed yearly and no outside hatching is carried on. The larger machines cost less in proportion to their capacity than the smaller ones.

INCUBATOR CELLAR OR HOUSE.

Incubators are successfully operated in a great variety of places. Where only a few small machines are used they are generally kept in the cellar or in a room of the house. A cellar is much better than a room, because the temperature is subject to much less varia-

tion and the air usually contains more humidity. A special cellar or incubator house should be provided when the incubator equipment is extensive or when mammoth machines are used. The main essentials are to have a room which is not subject to great variations in temperature and which is well ventilated and not too dry. A furnace used in a house cellar makes the place too dry for best results in incubation and necessitates supplying additional moisture, either by a tray or other device in the incubator or by keeping a large pan of water on top of the furnace. Both methods may also be used at the same time to advantage. Good results in hatching are obtained in incubator cellars and also in incubator rooms, which



FIG. 3.—Incubator cellar at U. S. Experiment Farm, Beltsville, Md., showing mammoth incubator and the testing of eggs.

are entirely above the ground level, but the former are much more commonly used. If the room is built above ground the walls should be double and the entire building well insulated. In sections which have a mild climate incubators may be operated in buildings with single walls, but a well-insulated room is preferable.

The incubator room or cellar should be large enough to allow the attendant to work around the machines conveniently. The ideal cellar should have a temperature of from 45° to 60° F., with a relative humidity of about 70, and should be from 8 to 9 feet high, with two-thirds of the cellar below the ground level. The shape and size of the cellar should be governed by the size of the incubators which are to be installed. Manufacturers of the various mammoth incubators furnish cellar plans for use with their respective machines. Many

incubator cellars are provided with some system of ventilation, such as the King system, in addition to the windows, while in others the ventilation is controlled entirely by the windows. The essential features are to keep the air in the room fresh and sweet. Muslin screens or shutters on the windows provide good ventilation without direct draft and at the same time keep the sun from shining on the machines. Many incubator cellars have cement floors, which are easier to keep clean than dirt floors. (See Fig. 3.)

SETTING UP AND OPERATING THE INCUBATOR.

Set up the incubator according to the manufacturer's directions, and see that the machine is perfectly level. If a spirit level is not available, a long, shallow pan of water set on top of the incubator can be used as a level to assist in setting up the machine. Be sure that all parts of the incubator are in their proper positions and that the regulator works freely. If the door of the incubator sticks, do not plane it off until the machine has been heated up and thoroughly dried.

Most operators attend to their incubators two or three times daily, and occasionally make extra trips as conditions require. Incubators require careful and regular attention, which, though simple, is very exacting. If attended to regularly, incubators do not take much time, while neglect generally shows its effect on the hatch.

REGULATING THE TEMPERATURE.

Run the machine at about 102° F. for at least a day before putting in the eggs. It takes several hours for the machine to come back to its correct temperature after the eggs are put in; therefore the regulator should not be touched during that time. See to the regulation of the temperature of the incubator before opening the door of the machine to attend to the eggs. Do not change the regulator any more than is absolutely necessary. As the embryo develops it may be necessary occasionally to change the regulator slightly. The temperature of the egg chamber may be regulated by lowering the flame of the lamp in the middle of the day if the room is subject to a considerable rise in temperature at that time. The machine should receive care enough to keep the temperature nearly even.

The correct temperature depends on the position of the thermometer in the egg chamber. The manufacturer's directions should be followed without change unless considerable experience has indicated that they can be improved. The possible need of such change is due to the fact that a manufacturer can not make a machine and rules which will be suited to all conditions. When the bulb of the thermometer rests directly on the eggs, the temperature should

usually be held at $101\frac{1}{2}^{\circ}$ to 102° F. the first week, 102° to 103° F. the second week, and 103° F. the third week. A hanging thermometer calls for a temperature of about 102° to $102\frac{1}{2}^{\circ}$ F. the first two weeks and 103° F. the last week. At hatching time allow the temperature to go up to $103\frac{1}{2}$ or 104° F. In a good hatch the chicks in the eggs begin to pip on the evening of the nineteenth day, and most of the chicks will be out of the shell on the morning of the twenty-first day. If the hatch is much earlier or much later it indicates that conditions during incubation have not been right.

CARE OF THE LAMP.

Use good oil. Clean and fill the lamp once daily, trimming the wick by scraping the charred portion off with a knife or square-edged nail or by cutting the wick with scissors. The burners should be kept free from dirt and thoroughly cleaned by boiling after each hatch. A new wick for each hatch is a good investment, thus eliminating any danger of the wick's becoming too short. Turn the eggs before caring for the lamp, so that there will be no chance to get oil on the eggs. The flame is apt to increase in size after lighting; therefore it is advisable to return a few minutes after lighting the lamp to see that the flame is all right.

TURNING AND COOLING THE EGGS.

Eggs should be turned at least twice daily from the second until the eighteenth day, when the chicks are due to pip. When mechanical devices are used to turn the eggs so that very little time is consumed, it is usually advisable to turn the eggs three or four times a day. After turning the eggs, reverse the egg trays end for end, and from one side of the machine to the other in two-tray incubators. With most machines it is usually advisable to keep the incubator door closed while turning the eggs. Be very careful to turn the eggs gently, to avoid cracking or jarring them, as rough handling may prevent the germ from developing. Various mechanical devices are used for turning the eggs in large incubators, but with small machines most poultrymen prefer to shuffle the eggs with their hands, removing a few from the center of the tray and working the others toward that point, placing those which were taken out on the sides of the tray. Cracked eggs may be saved by putting court-plaster over the crack, but this is advisable only when the eggs are very valuable.

The length of time required for cooling eggs depends on the temperature of the incubator room and the size of the air cells in the eggs. A good general rule is to leave the eggs out of the incubator until they feel slightly cool to the hand, face, or eyelid. They should be cooled once daily after the seventh and through the eighteenth

day. The operator should be guided by the air cell, which should increase gradually in size; this indicates a gradual development of the embryo (see Fig. 4). If the development is too slow, cool the eggs for a longer period and use less moisture. If development is too rapid, add more moisture and do not cool the eggs so long. An inexperienced person can get helpful information on the proper size of the air cell during incubation by setting a hen and comparing the eggs under the hen with those in the incubator.

To cool the eggs remove the trays and place them on top of the machine or on a table so that they are not in a draft and so that the tray does not project over the edge of its support and thereby allow part of the eggs to cool much more quickly than the rest.

CARE OF MACHINE AT HATCHING TIME.

After the eighteenth day, at which time the chicks usually begin to break through the shells, close the incubator and do not open the door until the hatching is well over. Do not open the incubator to see how the eggs are hatching, as this allows the moisture to escape, causing many of the chicks to become dry and stick in the shells. In a machine with a moisture pan in the bottom the common practice is to remove the pan just as soon as the hatching is over. The incubator door should be closed as quickly as possible after this pan is removed. If there is a big hatch so that the chicks are too crowded, it may be necessary to remove some of the chicks before the hatching is entirely completed and put them into the brooder. Most machines are arranged with a movable wire piece in the front of the egg tray which is opened when the hatch is completed so that the chicks can get down into the nursery tray after they are dried off.

As soon as the chicks are through hatching, remove the dead eggs and shells and place all the chicks in the nursery trays; then set the incubator door slightly ajar to allow ventilation to dry off and harden the chicks before removing them to the brooder. Keep the temperature in the incubator, taken at the level of the chicks' heads, at about 94° F. for from 36 to 48 hours after the hatch is complete: then remove the chicks to a brooder in a covered box, being careful not to permit them to become chilled while being transferred.

If the chicks are to be shipped a long distance, so that they will be on the road two or three days, it is better to ship them as soon as the hatching is over and they are thoroughly dry.

Chicks which pip but are unable to get out of the shell by their own efforts rarely amount to much if helped out, although, if desired, when most of the eggs are hatched and the chicks dried off so that they will not be injured by opening the incubator door, any which have pipped may be helped out by cracking the shell and placing them back on the egg tray.

MOISTURE AND VENTILATION.

Moisture and ventilation are closely related factors in incubation, the amount of each depending on the other. The former is one of the uncertain factors, for as yet no very satisfactory rules have been evolved which will cover all conditions. Good hatches are obtained both with and without using moisture, under apparently similar conditions, while each operator generally works out by experience the best amount of moisture to use under his conditions. When the moisture and ventilation are properly regulated, the correct heat will produce a normal chick at the end of the incubation period. Too much moisture may prevent the normal evaporation necessary to allow space enough for the chick to turn in the egg and break the shell, while too little moisture may cause the chick to become dried

and stick to the shell. Moisture is used extensively in hatching in the South, in high altitudes, and in places where the incubator is run in a dry room.

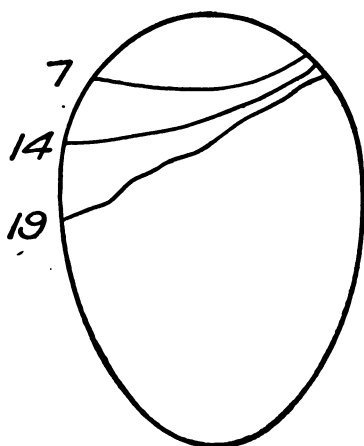
In order to supply moisture in incubators many methods are used, such as sprinkling or spraying the eggs with water, or placing a pan of water, a receptacle containing moist sand, or a wet sponge in the incubator below the egg tray. Another common method of supplying moisture is to sprinkle or soak the floor of the incubator room or to keep a pail of water under the lamp.

Figure 4 shows the comparative size of the air cell in an egg on the

FIG. 4.—Diagram showing the air cell on the seventh, fourteenth, and nineteenth days of incubation.

seventh, fourteenth, and nineteenth days of incubation. This air cell varies in size with the size of the egg, while the shape varies greatly in different eggs. If the air cell is too slow in enlarging, too much moisture has been supplied; while too large an air cell indicates that more moisture and less cooling should be given. Moisture on the glass door of the incubator during hatching time is the best indication of correct moisture conditions during incubation.

If a moisture tray or a sponge has been added to a nonmoisture machine, it should generally be taken out before the chicks pip. In this case sprinkle the eggs thoroughly and put them back into the incubator while still steaming, closing the incubator door immediately to retain the moisture. The question of moisture depends largely on the place where the incubator is operated. If in a room



in a dwelling house, it is frequently necessary to add moisture even to nonmoisture machines, while such machines run in an ordinary cellar in the same building might not need any extra moisture. When a large number of lamp machines are operated in one room extra moisture is more necessary than if only a few are kept together, while more moisture must be supplied in a very dry than in a humid climate.

As the weather becomes warmer more moisture is generally used than earlier in the season. Many operators supply moisture only just before they shut up the machines at hatching time, spraying the eggs being the most common method used.

TESTING EGGS.

An egg, whether impregnated or not, has a small, grayish spot, known as the germinal spot, on the surface of the yolk. As soon as a fertile egg is placed under a hen or in an incubator development begins. All eggs should be tested at least twice during the period of incubation, preferably on the seventh and fourteenth days, and the infertile eggs and those with dead germs removed. White eggs can be tested on the fourth or fifth day, while the development in eggs having brown shells often can not be seen by the use of an ordinary egg tester until the seventh day. Eggs with dead germs soon decay and give off a bad odor if allowed to remain in an incubator. Infertile eggs make good feed for young chickens and are often used in the home for cooking purposes.

A good homemade egg tester, or candler, can be made of a box which, set on end, is large enough to inclose the light or lamp. A hole slightly smaller than an egg should be cut in the side of the box at the same level as the light. An electric, gas, or kerosene lamp may be used. If a kerosene lamp or a gas lamp is used, there should also be a good-sized hole at the top end of the box; otherwise the heat from the top of the chimney may set the box on fire. Some incubator manufacturers furnish with their machines testing chimneys which fit the incubator lamps. (See Fig. 5.)

The eggs are tested with the large end up, so that the size of the air cell may be seen as well as the condition of the embryo. The testing should take place in a dark room. The infertile egg when held before the hole with the lamp lighted inside the box looks perfectly clear, the same as a fresh one. A fertile egg shows a small, dark spot, known as the embryo, with a mass of little blood veins extending in all directions, if the embryo is living. If the embryo is dead and the egg has been incubated for at least 46 hours, the blood settles away from the embryo toward the edges of the yolk, forming in some cases an irregular circle of blood, known as a blood ring. Eggs vary in this respect, some showing only a streak of blood. All infertile

eggs should be removed at the first test. The eggs containing strong, living embryos are dark and well filled on the fourteenth day and show a clear, sharp, distinct line of demarcation between the air cell and the growing embryo, while eggs with dead germs show only partial development and lack this clear, distinct outline.

CAUSE OF POOR HATCHES.

The cause of poor hatches is a much-discussed question and depends on a great variety of circumstances. A poor hatch is more



FIG. 5.—Testing eggs to see whether they are fertile and the air cell is of proper size. This style of chimney is furnished with many incubators for use on the incubator lamp.

likely to be due to the condition of the eggs before hatching than to incubation, although improper attention to either factor will produce the same results. When eggs fail to hatch, find out whether the breeding stock is kept under conditions which tend to produce strong, fertile germs in the eggs; see whether the eggs have been handled properly before incubation, and note whether the conditions were right during incubation, as judged by the time and condition of the hatch.

A daily temperature record may be kept of each machine; the operator can thus compare the temperatures at which the machines have been kept. Such records may prove of value in the future work, especially if the brooding records can be checked back against those of the incubator.

DISINFECTING INCUBATORS.

After the hatching season is over, clean and disinfect the incubators, empty the lamps, and carefully store the parts inside the machine. The incubator should be disinfected once a year, or oftener if any disease is present in the hens or chickens. Some operators prefer to disinfect their incubators before or after each hatch. A strong solution of a reliable coal-tar disinfectant may be used to wash out the machine and to disinfect the egg trays and nursery drawer. If the burlap on the bottom of the incubator is very dirty it may be cheaper to renew than to clean it.

SUMMARY.

Follow the manufacturer's directions in setting up and operating an incubator.

See that the incubator is running steadily at the desired temperature before filling with eggs. Do not add fresh eggs to a tray containing eggs which are undergoing incubation.

Turn the eggs twice daily after the second and through the eighteenth day. Cool the eggs once daily from the seventh through the eighteenth day.

Turn the eggs before caring for the lamps.

Attend to the machine carefully at regular hours.

Keep the lamp and wick clean.

Test the eggs on the seventh and fourteenth days.

After the eighteenth day do not open the machine until the chicks are hatched.

Poor hatches may be caused by setting eggs from weak or improperly cared-for breeding stock, by lack of proper care in incubation, or by faulty methods.

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